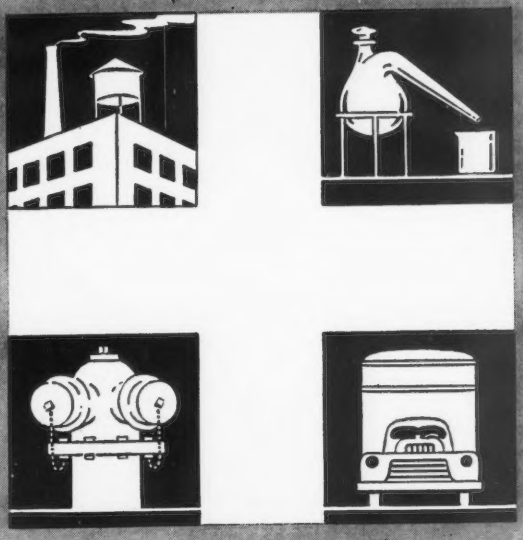
The Journal

OF THE AMERICAN SOCIETY OF SAFETY ENGINEERS



NOVEMBER, 1958

Volume III Number 4

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Fission and Safety Men

Every day, it seems, the use of nuclear materials by government and private industry becomes more prevalent. Potential hazards are many but to date the safety record is enviable.

Since this atomic age in which we find ourselves still is comparatively young, uses for fissionable substances probably will continue to increase rapidly for many years, accompanied by technological advances in methods of production, handling and storage of these materials.

Any safety engineer may find himself, almost anytime, faced with new accident prevention responsibilities involving problems of radioactivity. If the nation's excellent safety record in this field is to be maintained, it is becoming more and more necessary for all safety men to be well informed.

We feel the Journal should be alert to all opportunities for presenting authoritative information on the subject and, therefore, are most happy to publish, on page 61 of this issue, Leonard R. Solon's basic and valuable article, "Nuclear Safety Considerations in the Processing of Fissionable Materials."

Incidentally, Mr. Solon's career is illustrative of the fact that the atomic age is fast reaching maturity. When he was graduated from Rutgers (with an M.Sc.) in 1949, he immediately took a position as a nuclear physicist. Others with similar experiences form a sizable group of men who have every possibility of spending their entire professional lives in nuclear work.—Editor

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Organized 1911 — Chartered 1915

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Opinions expressed in articles published in the Journal are those of the authors and are not necessarily endorsed by the American Society of Safety Engineers.

OUR PRESIDENT SPEAKS ON SAFETY

It is helpful to spend a few minutes in self-examination. How often do we sit back and ask ourselves, "What are our responsibilities as safety engineers within our respective companies and are we doing everything possible to fulfill these responsibilities?"

We are expected, through various means, to improve the accident experience of those operations on which we apply our time and energies.

We have a primary responsibility to improve the frequency and severity records. In our efforts to accomplish this, we have a responsibility to our managements to present sufficient facts to "sell" them and secure their much needed backing to make our safety programs truly effective.

We also have a responsibility to all foremen and supervisors to explain our ideas so clearly and enthusiastically that these people will work devotedly on controlling accidents in their respective jurisdictions.

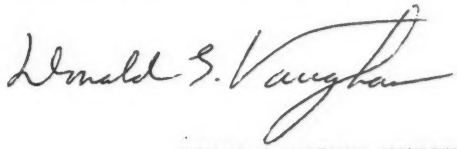
We have a responsibility to the worker to see that he is educated in safe practices. While we are not expected to take on this task with each separate, individual worker, it is our responsibility to see that the proper instructions get down through the organization to each employe. How this is accomplished depends on our channels of instruction, which vary among companies. Basically, however, it is our responsibility to see that the necessary instructions pass along the complete route, from top management to supervisors and eventually to every worker.

We have a responsibility to see that operations are provided with the best possible mechanical safeguards.

We also have a responsibility to see that others in our organization assist us. We can make use of the Personnel Department, the Employe Training Department, the First Aid Department and others. Whatever means we use to accomplish our purpose must depend on the facilities available and our own ingenuity.

How often do we sit back and ask ourselves, "Have we fully discharged all of these tasks?"

In order to accomplish our primary responsibility, have we provided as safe a place as possible for all workers to carry out their respective assignments? Have we used all possible means to see that safety education has effectively permeated all channels from top management to each individual employe? I am sure that, after a few minutes of such reflection, we can find several places where improvements can be made or efforts can be intensified and where we can employ new avenues of approach.



DONALD G. VAUGHAN, PRESIDENT
AMERICAN SOCIETY OF SAFETY ENGINEERS

Safety Training for Foremen

BY DAVID L. ARM AND GLENN F. GRIFFIN

DAVID L. ARM

"Safety Training for Foremen," which is published on the following pages, was one of 12 major papers presented at the Second World Congress on the Prevention of Occupational Accidents, held May 19-24, 1958, in Brussels, Belgium.

The Congress, which had the participation of some 40 countries and 2000 delegates, was aimed at identifying the major problems of occupational safety and considering solutions which have been developed in various parts of the world. A system of simultaneous interpretation was used at the Congress and all proceedings were published in the six official languages of the meeting — Dutch, English, French, German, Italian, Spanish.

In considering its American publication of "Safety Training for Foremen," the Journal found particularly noteworthy the fact that Society member David L. Arm, who represented the National Safety Council at the Brussels meeting, was the only delegate from the entire Western Hemisphere who was scheduled to present a major paper.

Mr. Arm, who became manager of NSC's Industrial Department in 1955, previously was dean of the School of Engineering, University of Delaware, for nine years. He is a registered professional engineer in Pennsylvania and holds a BS and MS in mechanical engineering as well as a professional ME degree. In addition to our Society, he is a member of ASME and ASEE.

The paper which Mr. Arm presented was coauthored by Glenn F. Griffin, NSC's director of industrial training and production of industrial training films. After experience in personnel, training and safety work, Mr. Griffin joined the Council staff in 1935. He has held his present position since 1945.

Since the text of "Safety Training for Foremen" was published and distributed to World Congress delegates before the May 23 session at which it was scheduled, Mr. Arm did not deliver it verbally at that time. Instead, he opened the planned discussion period on the paper with brief introductory remarks, which appear in the Journal immediately following the principal paper.

A number of prepared discussions on "Safety Training for Foremen" were submitted to the World Congress as supplements to the Arm-Griffin presentation. Among these supplementary papers were four written by Society members — John A. Dickinson, Edgar N. Goldstine, Thaddeus J. Ostrewich and Fred O. Soughton — and the Journal also has availed itself of the opportunity to publish these discussions in this issue although it has been necessary, because of space limitations, to condense slightly the original texts.

GLENN F. GRIFFIN

In the United States of America, leaders of business and industry, and the companies they represent, have joined together to promote good programs of accident prevention. During the last 44 years, these efforts have been coordinated through a voluntary association, the National Safety Council. Although they are not forced to do so by stringent laws and regulations set up by governmental units, these business leaders voluntarily conduct excellent programs of occupational accident prevention because they believe that safety is good business. They are convinced that safety for all employes is good business, not only from an economic point of view but for humanitarian reasons as well.

They have learned that good occupational safety programs lead to better efficiency of production, better quality of product and lower costs. In a free enterprise system, these are important considerations since they enable business to make a profit — the incentive for establishing and conducting such enterprises. They also have learned that these programs lead to good employe morale and good community relations. In addition, one of the guiding principles of business management in America is a sincere concern for the health and welfare of all employes. Through good occupational safety programs, this concern finds its best expression.

Foreman's Responsibility for Safety

In American industry, those safety programs which are most successful are the ones where all levels of management not only support but actively participate in their conduct. Safety is looked upon as a function of line supervision and the primary responsibility for accident prevention rests with the foreman.

There are good reasons for placing this responsibility on foremen since they are the members of management who have the closest personal contact with the workers. It is their responsibility to train their men in proper work procedures, to retrain them when necessary, to schedule production and assign work, to check on performance, to watch quantity and quality of production and to keep production costs at a minimum. These supervisors represent all of management to the workers and their efforts have much to do with whether or not good employe morale is maintained. Since safety is such an important factor in production, it is logical that it should be a natural part of the supervisor's duties.

A professional safety man guides foremen in a great many American firms. His normally is a staff position and it is his responsibility to plan safety programs, to keep management advised as to their progress and to assist supervision in matters of accident prevention in every way possible. However, he is not responsible for the day-to-day supervision of safety activities within the various departments of a firm and it is generally conceded that this should not be his function since it is properly a function of the foreman to supervise all activities of all workers under his jurisdiction. A surrender of any part of the supervisory function would weaken the position and the authority of the foreman with the workers.

Objectives of Safety Training for Foremen

Since the primary responsibility for safety of the workers has been placed upon the foreman, a great many American firms give foremen special training in this aspect of their jobs in order to achieve the following objectives:

1. To acquaint foremen with the company's accident policy and program.
2. To establish the status of the foreman as the person responsible for preventing accidents.
3. To get foremen to understand the nature of their responsibilities and the responsibilities of others in the organization.
4. To provide foremen with special information on accident causes and methods of prevention.
5. To give foremen an opportunity to consider current accident prevention problems and to develop solutions.
6. To help foremen gain skills in the activities necessary for accident prevention.
7. To give foremen help in current safety projects in their own departments.
8. To get foremen to participate actively in the planning and conduct of the company's entire safety program.

Basic Courses for Supervisors

To achieve these objectives, foremen often are given formal courses of instruction in accident prevention. Courses of instruction in all aspects of foremanship are rather well known in the United

States. The usual plan is for the foremen to meet in a two hour meeting about once a week for several weeks. Foremen meet in small groups and much of the instruction is done by discussion.

A course in safety for foremen usually follows this same pattern. A list of course subjects recommended by the National Safety Council, and rather generally used, includes:

- Fundamentals of Accident Prevention
- The Foreman's Place in Safety
- Mechanical Safeguarding
- Safety in Materials Handling
- Personal Factors in Safety
- Job Instruction and Supervision for Safety
- Accident Costs and Their Effect on Production
- Causes of Accidents and Basic Methods of Prevention
- Fire Prevention
- Plant Housekeeping for Safety
- Problem People Who Cause Accidents
- Safety Committees and Other Cooperative Activities for Safety

In every company, there is likely to be variation from this list of subjects but the subjects named are the main ones taught.

In those American companies where accident prevention has been most effective, all supervisors are given a basic course of this nature. Also, the course is repeated from time to time for new supervisors and for prospective supervisors.

However, not every American company goes to such lengths. Two difficulties have kept many companies from doing this kind of safety training. First, they often are not able to employ a professional training man qualified to prepare the lesson outlines and teach the course. Second, even if they have employed a professional training man, the amount of time and money it takes to prepare material, particularly the visual training aids such as films and charts, makes such training seem uneconomical.

The National Safety Council has sought to overcome these difficulties by preparing courses with compelte teaching guides for each lesson, an interesting film on the subject of each meeting and detailed instructions for the leader who is to conduct the classes. With these prepared course materials, it is easy for any company to conduct good courses in safety for foremen. American industry has accepted these aids and has used them with a great deal of success.

The first foremen's course using films was offered about 15 years ago. This technique was so successful that many additional films were made, all planned as teaching aids. Now it is possible for a company safety director to select subjects and films for two or three successive courses, or for repeat courses for the same group, without repeating the films.

Another major training aid for foremen has been a work called the *Supervisors Safety Manual*, published by the National Safety Council. This is a 350 page book of 12 chapters covering the safety subjects just mentioned a few moments ago. It is designed to use as a text for a course given to a group or it can be used by a supervisor studying alone. A complete instructor's guide with quizzes, discussion questions and references, lists of suitable training films and other visual aids, has been developed and is in constant use.

Spectacular benefits often result from a supervisor's safety course. Among them are increased understanding of safety, acceptance of responsibility for the prevention of accidents and greater interest in all supervisory duties. A prominent American industrialist, J. E. Trainer, vice president of Firestone Tire and Rubber Company, summed up the effects of safety training when he stated that "in any well organized program, the safety training courses go far beyond the accident prevention field itself and make the supervisory employe a better all-around member of the management team."

Further Methods of Supervisor Education

Personal Instruction—Some further methods of supervisory education are personal instruction by the professional safety man, work projects and safety meetings. Personal instruction and coaching by the safety man have been extremely valuable. Where the safety man and the foreman have met privately to talk over the job, a free exchange of ideas has been experienced that is not possible in a group. In private conversations, foremen have expressed reservations or doubts that they preferred not to voice in a public meeting and thus safety men have been able to clear up misunderstandings.

Foremen appreciate interest in their work and

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usually are eager to teach others about the processes in their departments. Safety men, in turn, have learned much from foremen about mechanical processes and also about problems of supervision.

Work Projects—Probably the best kind of safety training for foremen comes when they actually do a job that needs to be done. Small groups of foremen, working with the safety man, implement and augment their company's safety program by undertaking projects for which they are well qualified. Examples of such projects are setting up plant inspection procedures, developing checklists, developing rule books, studying accident costs, and setting up contests. Foremen undertaking such projects often acquire a proprietary interest in the safety program as well as a good deal of skill and factual information.

Foremen's Safety Meetings—Safety meetings for foremen are held periodically in a great many American firms even when no formal training program is being conducted. If the company sponsors regular foremen's meetings to consider general supervisory matters, including safety, special safety meetings are held only three or four times a year. If no other foremen's meetings are held, safety meetings are more frequent, perhaps once a month or once every two weeks.

Programs for foremen's safety meetings sometimes are planned by a Foremen's Committee in cooperation with the Safety Department or by the Safety Department alone. Program subjects commonly presented are the company's accident experience, a talk on some new and interesting aspect of safety, a new safety film, discussion of a particular category of accidents, recommended preventive measures.

Supervisory Skills

We have learned in America that success in safety supervision requires skill fully as much as it requires knowledge and understanding. Basic training courses in the elements of a safety program impart knowledge about safety and create a positive attitude toward safety but they are not enough. Skill in accident prevention by American foremen has come from practice in performing specific safety functions. In those American firms where accident prevention has been most successful, such skills have been developed to a very high degree.

Among the most important safety functions performed by American foremen are (1) giving job instruction, (2) investigating and analyzing accidents, (3) discovering accident costs and (4) resolving problems in safety supervision.

Job Instruction—The first of these, job instruction, is not exclusively a safety measure. Rather, it aims at increasing production efficiency. Nevertheless, good job instruction is so essential to safety that often it is incorporated into the safety program when it is not otherwise being promoted.

Foremen skilled in job instruction train new workers better and in less time than when "breaking in" is casual and unplanned. Able foremen first break a job down into its component parts by going through the job carefully, step by step. A written record is made of what has to be done and why. This report enables the foremen to determine exactly what must be taught.

The foreman goes over the report to be sure that safe working procedures are incorporated into job routine and that hazards are removed or guarded. The finished report then becomes the standard method by which this job is taught and done. Deviations from this standard are easily observed and corrected, and possible hazards are controlled.

One method foremen use in checking for all possible hazards employs a hazard spot card. The card lists hazard "areas": the work place, the machine, materials handling, use of tools, etc. By following the list, a foreman makes a complete safety study of the job.

Investigation and Analysis—A second safety skill that American foremen have developed involves the investigation and analysis of accidents. It is a safety axiom that accident patterns repeat and that a close study of past accidents is a guide toward preventing their repetition. Therefore, our foremen have learned to isolate and identify the causes of accidents in order to permit direct and positive action to be taken to prevent their recurrence. In many plants, all accidents causing injury are investigated, frequently by the foreman because he is the man closest to the job. In some plants, near accidents or noninjury

accidents also are investigated if time and facilities are available.

Discovering Accident Costs—A third safety skill that has been developed is the discovering of accident costs. American foremen are cost conscious because they are expected to run their individual departments profitably. They realize that accident costs within their department are a reflection of their ability to run their department economically. Consequently, they have been motivated toward paying attention to safe operating procedures.

Problems in Supervision—A fourth safety function performed by foremen is safety supervision. Skill in handling problems of safety supervision has not been easy for American foremen to acquire. Many accidents have resulted from workers not following instructions, from jobs not being well planned, from foremen not knowing the problems workmen are encountering and from foremen assuming that workers have more information than they really do have. Accident investigation and analysis has helped foremen in learning how to handle such problems. Even greater progress has been made when foremen have developed skill in human relations.

One method of training foremen in handling safety supervision problems requires them to deal with hypothetical supervisory situations in a role playing (play-acting) demonstration. Other foremen attending the demonstration are invited to criticize a particular foreman's handling of a problem and present solutions of their own. Common faults in handling people thus are revealed.

Policies and Attitudes in Education

The American approach to supervisor education naturally has evolved as a result of many years' experience. Certain policies and attitudes now prevail, some of which are summarized here.

First of all, the person conducting a program of education for foremen should remember a number of facts which experienced educators know. One such fact is that supervisors are adults who may well resent being treated like school children.

The average foreman already is an experienced, successful and busy person who probably knows much more about practical supervision than does the person conducting the safety course. The foreman is intensely aware of and proud of the fact that his job is to get out production. He often is impatient at being asked to do work which takes his attention from that main purpose.

At the same time, the foreman usually reflects the attitude of his immediate superior as to what is important and what can be ignored. If a superintendent lets it be known that he insists upon safety and that he judges his foremen on the safety of their departments as well as on their production, the foremen are likely to give attention to any instruction that will help them operate more safely. This fact is a strong argument for starting safety education at the upper levels of supervision.

Foremen sometimes are difficult students because they will pretend to agree with an instructor's ideas in order to get along while actually believing the ideas to be visionary and impractical. An instructor who merely lectures about safety, week after week, may not encounter any disagreement but the foremen probably will neither change their attitudes nor acquire new knowledge or skill. For learning to take place in a foremen's study group, the members have to think about the subject under discussion as it relates to their own work. They have to raise questions, express their views and report their experiences. When they do these things, the smooth flow of instruction often is interrupted but real results in learning are accomplished. It is much more important for people to learn than it is to cover a specific amount of subject matter.

Training Upper Level Supervisors—Much emphasis in America has been placed upon the training of foremen or first line supervisors. Training in safety also should be given to superintendents and upper level staff people who are in positions of authority over foremen. If these people of higher rank do not have the knowledge of safety and the interest in safety that foremen have, two harmful effects can be expected.

First, foremen will be handicapped because they will not get full support for activities they wish to conduct. Second, foremen naturally will have much less interest in safety since they are guided by the attitudes of their superiors.

Perhaps the best of all arrangements is for upper level supervisors to be trained as instructors so that

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they can conduct the classes for first line supervisors. This plan has worked successfully in many companies.

Integrating Safety—In a company which has a formal training program, the director of training and the safety director should work together in the planning of various kinds of safety training activity. Almost everything that is taught about good supervision helps to promote safety. Likewise, practically everything that is taught to promote safety improves supervision in other ways.

In the arrangement of formal courses, safety subjects may be integrated with other instruction on general problems of supervision or one or two safety meetings may be included in the course. The basic course in safety fundamentals probably is given best as a unit, with a training season of 10 to 15 weeks set aside for weekly meetings.

In a company which does not have a planned supervisor training program, the success of safety training very well may lead to a program of training in other aspects of supervision.

A Continuing Program—Safety education for supervisors needs to be a continuing program if it is to accomplish the best results. The program should cover many subjects, presented interestingly and in different ways. A small effort, such as holding a few meetings, may cause foremen to do a better job for a short time but interest will lag if the initial effort is not followed up.

Industrial management is dynamic. Change is continually taking place. New methods and new ideas get attention. To hold its own in this environment of change and progress, safety must not be allowed to become static.

The safety professional who strives constantly to help line supervisors take over direct responsibility for safety in their operations finds the results of his efforts multiplied many fold. He becomes a true leader who gets the job done better, not by extending the scope of his own activities but by helping supervisors assume their natural safety responsibilities.

Introduction to Discussion Period

BY DAVID L. ARM

The following remarks were made by Mr. Arm as a preliminary to presentation of prepared discussions on his and Mr. Griffin's paper at the World Congress session on "Safety Training for Foremen."

In opening the discussion on this paper, I should like to mention some of the reasons why we believe the foreman is so important in any good industrial accident prevention program and why safety training is so important.

First, however, I should like to explain two philosophies in which we believe in the United States of America.

Reasons for Accident Prevention—As we have indicated in our paper, there are two reasons why American business is interested in good programs of accident prevention—humanitarian and economic. We make no apology for either reason.

We sincerely believe in the dignity of the individual and in his rights and privileges as a free human being. Among these is included the right to be protected from injury or death due to accidents. Our thinking is well expressed by the primary rule of the American Telephone and Telegraph Company, which says, "No job is so important or so urgent that we cannot take time to do it safely." I can assure you that this attitude of management toward safety is not unique with this one company but is the attitude of American business management as a whole. The safety of the individual is so important with us that it transcends all other considerations.

The economic reason for good safety programs in our industrial establishments is equally defensible. In our free enterprise system, we not only desire business to make a profit—we expect it. Since this is true, we believe that cutting costs of operation through the elimination of the costs of accidents is a legitimate business practice. We would emphasize, also, that good programs of accident prevention relieve the worker and his family from economic stress. Not only is the worker spared from the suffering which results from injury; he is assured of continuing income from his employment.

Approaches to Safety Programing—Although all levels of management must be interested in and

Introduction to Discussion *Continued*

must accept responsibility for the safety program, the foreman or immediate supervisor of the workers is the key man in any accident prevention program. Outstanding safety records are being built where this is true; where not only is the safety engineer doing a good job but the entire line supervisory staff has assumed its responsibilities; where safety performance is a positive factor in consideration of a supervisor for advancement and increases in salary; where safety is a specific part of each job that is done in the plant.

There are two approaches to the operation of a safety program. One is where the Safety Department has certain supervisory responsibilities. In these cases, unsafe machines are tagged out by safety personnel rather than by line supervision. Safety personnel order the installation of machine guards.

An approach which seems to work better than this, in the plants which have good safety programs, is where the safety personnel do not have supervisory responsibilities but where they attempt to achieve their results through teaching, consultation and advice. In other words, the best programs seem to occur in those places where line supervision actually handles all problems of supervision, including safety.

Aid to Leadership—Why should first line supervision be interested in the latter method as compared with the former? In the first place, this method enables the supervisor to gain a greater acceptance of his leadership from the men whom he supervises. At the present time, competition as to wage rates, security and employe benefits have been largely eliminated in any particular geographic area. What then remains is the attraction of good workers by making a place known as a good place to work.

To be a leader, the supervisor must have the respect of the people whom he supervises. To win this respect, he first must show respect for them. The concern he demonstrates for the safety of the man on the job is a good indication of the respect that he has for his workers. This concern must be sincere and it must be constant. It must be a demonstration of the kind of personal interest the supervisor would have in accident prevention if his own son were working in the plant. Employes won't accept lip service. To win acceptance, the supervisor *really* must want to operate a safe plant and, by the example he sets, must let his people know that he expects them to want the same thing.

Essential to Efficient Operation—Disabling injuries and the so-called minor accidents, multiplied many times in the course of a year, add materially to the total cost of industrial accidents. The more serious accidents simply call attention to the problem. However, every accident interferes with production and anything that slows production and increases costs should be the concern of all supervisors.

Accidents, whether they cause personal injury or only property damage, destroy efficiency. Furthermore, they are symptoms that something is wrong. Accidents stem from lack of control over men, materials and processes, and lack of control indicates inefficient operations.

A high injury rate has a depressing effect on employe morale. Unsafe plant conditions, which contribute to accidents, lead to dissatisfaction and poor job performance on the part of the workers.

On the other hand, real pride and enthusiasm for the job exist in companies and departments that achieve outstanding safety records. Employes have a feeling of loyalty for the company and a sense of security on their jobs.

Good morale is worth a great deal to any company. The foreman who builds high morale among his men is rendering an important service to the business. He is doing the job he was hired to do.

Training Program for Supervisors—For these reasons a program of training in the methods of accident prevention, similar to that which we have outlined in our paper, is important. It would be very difficult for the foreman to learn these things as a result of his experience as a worker and as a supervisor. Accident prevention deals with those incidents which do not occur regularly and are unexpected. These are the exceptional situations which can disrupt greatly the normal flow of production but which can be avoided by firm, competent, sympathetic and alert supervision. The supervisor should be trained properly so that he can give this kind of supervision.

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Prepared Discussions on Safety Training for Foremen

BY JOHN A. DICKINSON

John A. Dickinson, chief of the Codes and Specifications Section, National Bureau of Standards, was official representative of the Society at the Second World Congress. In safety work for a half century, Mr. Dickinson is a charter member of the Society and of its forerunner, the United Association of Casualty Inspectors, organized in 1911.

For a number of years, it has been my privilege to serve with Mr. Arm on the Industrial Safety Conference of the National Safety Council. I appreciate the excellent job he is doing in the field of industrial safety.

Greetings from Society—As its official representative, I also bring you greetings from the American Society of Safety Engineers, a professional organization of more than 7,000 members. The Society's relation to the National Safety Council is much the same as the relation of the American Medical Association to the Red Cross. During one of its annual drives, the Red Cross used the motto, "Join the Red Cross—all you need is a heart and a dollar." On the other hand, the American Medical Association is open only to graduate doctors. In much the same way, membership in the American Society of Safety Engineers is limited to professional safety engineers.

Mr. Arm's paper is a most timely one and covers the various factors of foreman training quite adequately. There is, however, one aspect of foreman training which I should like to stress.

Let us consider reasons that a particular man (or woman) is chosen as a foreman. These might be:

1. He is a better or more skilled workman than those he supervises.
2. He knows more about the machines and manufacturing processes generally.
3. He can get along well with his fellow workmen.

Ideally, the foreman should excel in all of these phases but this is not always the case. In any event, he is a foreman because his superiors believe that he is a good production man; i.e., he can see that goods are produced promptly and in adequate volume.

Relation of Safety and Production—Unfortunately, many foremen believe that safety and production cannot go hand-in-hand. Actually, the converse of this is the truth but the true situation is one that sometimes is hard to "sell." The late Sidney J. Williams, for many years a key figure in the National Safety Council, frequently gave talks on the text that "an accident is an indication of poor management."

To take a concrete example, let us suppose that a man handling material on a fork lift truck has a heavy box fall on his foot and, in spite of wearing safety shoes, receives an injury which results in lost time. For every reportable accident from this source, there probably have been 50 or 100 cases where material has fallen from the truck or pallet but no one has been injured. After each one of these spills, time has been taken to replace the material on the truck; the falls may have damaged finished goods or partly finished items. Also, the spill may have blocked other trucks using the same aisle.

Effects of Hazard Removal—The accident may have been due to any one of a number of causes: material carelessly stacked, material piled too high, too great a speed around a corner, rough floors, etc. Whatever the cause, its elimination not only cuts down the particular hazard *but, at the same time, cuts down interruptions to production.*

With proper training, the foreman may be brought to the realization that safety and production do go hand-in-hand; that a reduction in accidents carries with it a bonus of increased production.

Safety training for foremen is an indispensable element in an effective accident prevention program. This training may take a number of forms which may be dependent in some measure upon the particular needs of the instructed, the ability and experience of the instructors and the extent of facilities for instruction.

Construction Industry Problems—While all foremen need to understand general principles of accident prevention, a particular knowledge of safe working procedures is indispensable in some particularly hazardous types of industry—notably lumbering, mining, quarrying and construction. This is due to the wide variety of working conditions and, in some degree, to the instability of the labor force due to irregular employment with the same employers. In these comments, the construction industry will be given specific consideration.

Subjects requiring special attention in construction include excavation, scaffold construction, ladders, handling of materials, use of hand tools, portable power tools, construction equipment, haulage of men and materials, barricades and warning signs, maintenance of good housekeeping, use of personal protective clothing and equipment, demolition, first aid. Some kinds of work also may require consideration of the use of explosives, drilling equipment, pile driving, work under compressed air, diving, etc.

Definite safety standards for approved working methods and conditions need to be developed and utilized. In the State of California many such standards have been incorporated in the recently revised Construction Safety Orders which have the force of law. Beyond these state requirements, other standards without legal status deserve consideration, such as correct methods of lifting and handling material by workers, fire prevention measures, etc.

Effective Training Method—One extraordinarily effective method for safety training of construction foremen, in the writer's experience, consisted of weekly instruction, primarily of one subject each week, about safe methods and conditions and ways for foremen to present this information to the workmen.

This indoctrination was given by the safety engineer in a class period that usually lasted from 30 minutes to an hour each Friday afternoon. An outline of prepared material was given to each foreman, to be used on the following Monday at his safety meeting with his workers, which was held the first 15 minutes of the working day.

BY EDGAR N. GOLDSTINE

Edgar N. Goldstine, consulting safety engineer, completed his BS in civil engineering in 1917. He began his career in the construction industry in which, 10 years later, he entered safety work. He also has had experience in the insurance field. A member of the San Francisco Chapter, he became a member of the Society in 1934.

At the Monday meeting with his men the foreman, in addition to covering the outlined material, also discussed particular hazards and the precautions to be used on the work to be performed during the week by his men. The workers then were invited to submit any questions or recommendations they might have for consideration. Accidental injuries which had occurred and unsafe work practices or working conditions observed were mentioned. Means for covering them were outlined. Blackboards were used to list the subjects and topics to be considered.

A Foremen's Committee was used to inspect portions of the work under their jurisdiction and hazards observed were recorded. If no hazards were observed on any part of the work, all of which was subject to inspection, a Green Cross safety flag was flown for that day at the entrance to the construction area where it could be observed by all employes.

Outstanding Safety Record—In one organization *the effect of this training of the foremen,* who in turn trained the workers (all of whom had been given three lectures, ten days apart, on the working conditions and the methods they were to observe, supplemented by printed and illustrated safe practice instructions), *was to develop a disabling injury record that was close to perfect.* This occurred on a construction operation with more than 500 men which continued for more than a year.

Accident prevention efforts of a similar nature and quality under the direction of competent safety engineers would contribute very much to the prevention of accidents throughout the construction industry—and in all other industries as well.

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BY THADDEUS J. OSTREWICH

Thaddeus J. Ostrewich is the executive manager of the Seguridad Industrial A. C. (Industrial Safety Society), which is headquartered in Monterrey, Mexico. Mr. Ostrewich has been engaged in safety work in Mexico and Venezuela, principally in the petroleum industry, for some 22 years. He became a member of the Society in 1947.

The industrialization of Mexico, which is in a state of continuous development, is a significant demonstration of the increasing progress of the country. In many branches of economic activity, new factories are being put up which increase output and give opportunities of work to an ever greater number of workers.

Need for Foreman Participation—It is natural that this remarkable advance opens the road to innovations, either of methods or of the kinds of occupations, tools or manufacturing processes. In order that men may carry out their work safely, it is important that effective supervision by a responsible agent can be relied upon. Under these conditions, the intervention of the foreman becomes a decisive factor in accident prevention.

In dealing with the accident problem, we must consider not only injuries to workers, although this is our primary concern, but also possible damage to machinery, tools and materials, for these damages weigh heavily on the cost of production.

Empty oratory is not enough to sell safety to workers; one must have, and impart, genuine enthusiasm. Accident prevention is an ideal and a duty which one must carry out and it is impossible to do so without the full collaboration of the worker who is conscious of his value and anxious to apply the rules and principles of safety to his daily tasks.

Factors in Job Performance—The foreman should keep in mind that the same factors which contribute to a worker's poor job performance are also the chief causes of industrial waste, such as:

1. Lack of "know how" and of attention in handling both raw materials and finished products.
2. Improper use and maintenance of tools.
3. Improper handling of machines and equipment.
4. Negligence in handling and maintaining machinery.
5. Failure to use proven work methods.
6. Inexperience of workers.
7. Indifference of workers to the value of looking ahead.

If the foreman is to bring to, and keep at, a high level the efficiency of his workers, he must recognize that the prevention of accidents is an integral part of his duties and that he must correct any workers who are at fault.

The foreman must never lose sight of the fact that accidents do not happen by themselves—they are the result of an imprudent act, the existence of a mechanical hazard or both.

Purpose of Investigation—The foreman should seize every opportunity to show the workers that the chief object of investigating accidents is:

1. To avoid a repetition.
2. To detect imprudent methods of work.
3. To find those working conditions which may be hazardous.
4. To stimulate suggestions for improving working conditions.

In order to obtain complete and trustworthy information on accidents, the foreman must convince his men that the purpose of his investigation is not simply to find out who is responsible and take disciplinary measures. Otherwise, the workers will try to cover up the facts to shield anyone at fault.

Success in Supervision—But if the foreman will take advantage of his opportunities to talk with the men under his supervision, he will find his safety efforts becoming more successful because:

1. He will come to know the workers' attitudes.
2. He will learn more easily the art of giving instructions.
3. He will have an opportunity to explain his own safety attitudes to his men.
4. He will be able to work up a feeling of team spirit among the men.
5. His own zeal will increase as his efforts to teach safety begin to show evidence of success.
6. He will be able to appreciate more fully the grievances which his men may present to him and to find solutions to problems before accidents occur.

BY FRED O. SOUGHTON

Fred O. Soughton is training coordinator for the Kimberly-Clark Pulp and Paper Company Ltd., Terrace Bay, Ontario, Canada. He entered safety work in the pulp and paper industry in 1948 and joined the Society in 1951. At the Second World Congress he represented the National Safety Council Pulp and Paper Section, of which he is past chairman.

Safety must be sold for the same reasons that products or politics are sold. And in any selling job the seller must be sold before he can sell well. In industry, the key to the safety selling job is the foreman. His attitudes, actions, convictions and training trigger the attitudes, actions, convictions and training of everyone he supervises. He must be trained well to be effective.

A vital segment of "Safety Training for Foremen" is the prime concept of the importance of safety, so necessary for a foreman as he deals with the accident prevention problem.

Part of Foreman's Job—Essentially, a foreman must think of safety as a component of his general responsibilities. And we must train and retrain him to think and act in these terms. Safety should be designated officially as part of his prime responsibilities, not as something separate, to be dealt with as time permits.

By accepting this principle, any industrial management can set the stage for an effective accident prevention program. Once the principle is established, certain specific guideposts should be set up whereby a foreman learns to deal with safety problems, as they arise, in the same manner that he deals with operating problems.

Standards for Safety—In safety, as in most areas of industrial activity, certain standards must be met. Every foreman should be able to survey his area of responsibility and define the standards he would have maintained. These should embrace equipment, materials and human performance.

1. Equipment standards should incorporate all mechanical guarding needed for safe operation.
2. Materials standards should define the safety factors for materials as well as equipment needed for their safe handling.
3. Standard operating procedures should constitute safe patterns of human activity, to be performed in a certain manner and sequence for a given purpose. Personal protective equipment requirements and proper use should be defined.

A foreman should be sure that everyone he supervises is well acquainted with these standards. For training and retraining, regular briefing sessions should be scheduled.

Continual conformance with the established standards should be the target of each foreman for himself and his staff. Regular checks should be made and nonconformance dealt with promptly.

Checklist of Acts and Conditions—A foreman should be taught to look for substandard safety situations and performance under two general headings: unsafe acts and unsafe conditions. Checklists should be developed; for example:

1. *Unsafe acts*—not working according to established procedures; working at unsafe speeds; not using equipment safety devices; using unsafe equipment; being in unsafe location; not using the personal protective equipment specified.
2. *Unsafe condition*—poor guarding; poor lighting; defective equipment or materials; improper arrangement of materials or equipment; poor ventilation.

Well developed lists, coupled with established standards, would constitute a substantial manual of basic safety information for any foreman. By developing this material for his own work area, a foreman actually is involved in self-training, which has considerable merit in itself.

When work injuries occur, adequate use of the written investigation technique, with recommendations for corrective action, can be helpful. A foreman is thereby able to determine, in general, the reasons behind equipment, materials or man failures and often is able to prevent recurrences. It also is advisable to consider investigating near injury cases and mishaps involving no person if it seems that corrective action could be recommended.

Support from Management—One other factor merits emphasis in this discussion. Part of the process of "Safety Training for Foremen" must involve foreman realization that he has full backing by his superiors in his efforts to reduce accident causes. Only as such support is assured will the foreman be able to work at accident prevention with conviction —the kind of conviction that will permeate his efforts to do an effective selling job and thereby measurably reduce work injuries.

Nuclear Safety Considerations in the Processing of Fissionable Material

BY LEONARD R. SOLON

One of the special aspects in the processing or storage of fissionable material is the possibility, however remote, that through carelessness, ignorance or accident a chain reacting or critical configuration may be achieved inadvertently. *Nuclear safety* is the prevention of the formation of an accidental critical configuration in the processing or storage of fissionable material.

Evaluation of Risk

Before discussing some of the considerations which enter into nuclear safety or criticality control, it perhaps is advisable to orient ourselves in the coordinate system of total technological risk, in order to understand better the magnitude of the nuclear safety problem. To establish this orientation, attention should be called to several facts.

1. It is public knowledge that the United States contemplates making available to the International Atomic Energy Agency some 5,000 kilograms or 11,000 pounds of uranium, enriched to 20 per cent uranium-235. This is mentioned to illustrate that fissionable material is not a rare or unusual commodity. It is in fact a commodity which, for more than a decade now, has been produced in such substantial quantities that, over and above the requirements of the United States, more than five tons of it can be made available to an international agency. One can deduce, in general, that fissionable material, at least in the form of uranium-235, exists in substantial and important quantities.
2. The other important fact, in orienting ourselves in the considerations of nuclear safety,

CONTEMPORARY nuclear technology, including the operation of power or research reactors and the production of radioisotopes, depends upon an isotope of uranium which is only 0.7 per cent of naturally occurring uranium. Intimately connected with uranium is the isotope plutonium-239, which does not occur for practical purposes in nature.* Plutonium-239 is derived from the abundant isotope of uranium (uranium-238), which in a nuclear reactor captures an excess neutron, becoming in the process the beta emitting isotope of uranium (uranium-239) and then, by two successive beta disintegrations, becoming first neptunium-239 and then plutonium-239.

For purposes of this discussion, another isotope which is capable of sustaining a nuclear chain reaction is uranium-233, which is not derived from naturally occurring uranium but is related to the natural and relatively abundant isotope of thorium in the earth's crust, thorium-232. Uranium-233 is obtained from thorium-232 in much the same way that plutonium-239 is obtained from uranium-238. First, neutron capture in thorium-232 forms thorium-233, which then decays by two successive beta disintegrations to form, first, protactinium-233 and then uranium-233. The latter has not yet achieved the importance of uranium-235 or plutonium-239 as fuel for a nuclear chain reaction.

**Plutonium appears in trace quantities as a consequence of neutron capture in U-238. The source of these neutrons is spontaneous fission in natural uranium and (alpha, n) reactions in light elements.*

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TABLE I

Critical Mass for Fissionable Materials

Material	Mass (gms)	Volume (liters)	Cylinder Diameter (in.)	Slab Thickness (in.)	Concentration (gm/liter)
U-235 (90% enriched)	800	6.3	5.0	1.4	11.6
U-233	588	3.5	4.0	0.5	10.9
Pu-239	509	5.0	4.5	1.5	7.8

Nuclear Safety Considerations *Continued*

is that there never has been a criticality accident in a production or fabrication operation involving fissionable material—either in the enrichment of naturally occurring uranium-238 or in the fabrication of enriched uranium or plutonium-239*. This does not say that there have not been inadvertent critical assemblies or criticality accidents. There have been both. In fact, in the Atomic Energy Commission program the only two fatalities associated with radiation injury occurred early in the program and were the result of criticality accidents. However, both of these fatalities resulted from experimentation, in which men deliberately were approximating a chain reacting situation, and neither fatality had anything to do with the preparation, storage or fabrication of these materials.

When these two points are considered together, it becomes clear that nuclear safety or criticality control is not an enormously difficult job.

When one contemplates the relative ease with which a chain reacting assembly can be made, the relatively large scale operations involving the processing, storage and transportation of special nuclear materials, and the comparative newness of nuclear technology, those of us who have certain responsibilities in the area of nuclear safety sometimes are impressed with this extraordinary record. With increasing knowledge and confidence in the handling of special nuclear material as more people become qualified in this field, it is to be hoped that this enviable record will be maintained.

The Fission Chain Reaction

One does not have to be a nuclear physicist to understand, in general, what is involved in the prevention of a nuclear accident. There are certain basic concepts which can be understood by technically trained plant personnel. When these concepts are communicated to persons engaged in special nuclear material fabrications, the necessary restrictions which are imposed upon such fabrications are understood and more readily implemented.

We begin by first considering the fission process:

The uranium-235 nucleus consists of 92 protons and 235 minus 92 (or 143) neutrons. When an additional neutron enters the uranium-235, a nucleus is formed in a configuration of great instability, with the result that the nucleus so formed divides or fissions into two nuclei of roughly equal mass. But in addition to these two nuclei, there is a surplus of two or three "left over" neutrons. This is the central phenomenon in all nuclear technology. If a suitable distribution of uranium atoms is made, one of these surplus neutrons can be captured by a neighboring nucleus of uranium-235, which in turn can experience fission. Thus, one can achieve the fission chain reaction or chain reacting assembly.

The business of the reactor designer is to effect neutron economy in such a way that conditions for a chain reaction are most readily realized. On the other hand, it is the function of the person responsible for nuclear safety, in processes involving fissionable material, to see that the chain reaction is not realized in storage or fabrication.

In general, nuclear safety is achieved by limiting the mass or concentration in a particular place or by designing processing apparatus, shipping containers or storage facilities so that the geometry for fission is unfavorable. Subsequent paragraphs will discuss general considerations which are pertinent in the planning of the processing, shipping or storage of such materials.

Solutions, Chips, Shavings and Sludges—A critical configuration which involves the smallest quantity of fissionable material generally consists of finely dispersed material in a hydrogeneous moderator.

**At the time of publication, it was learned that the first criticality accident in a processing plant occurred at Oak Ridge on June 16, 1958.*

such as water or almost any organic material. For this reason, particular attention should be given to processes involving scrap solutions, chips, shavings and sludges containing water, cutting oils or degreasing agents.

Total Flooding—The possibility of an operating area or storage vault becoming totally flooded with light water should not be carelessly excluded. A fabrication operation or a storage vault, which is properly designed from the viewpoint of nuclear safety, should not constitute a critical configuration even if totally inundated by water.

Double Batching—Allowance should be made for the possibility of operating personnel bringing together twice the recommended amounts of fissionable material.

Concurrent Unlikely Events—In general, a nuclear safety program should be planned so that at least two concurrent unlikely events must occur before fission can result. This latter criteria for nuclear safety perhaps can be illustrated best by an example:

The minimum critical mass for uranium-235 in an optimum dispersion in ordinary water is approximately 800 grams. It follows, therefore, that if one were to maintain 400 grams of uranium-235 powder in a container and that if this 400 grams of powder were to be transported from one area in a plant to another, no conceivable contingency of dispersion could give rise to a nuclear accident.

Uranium powder being a pyrophoric material, it is possible that, as a result of a fire, the uranium could be dispersed in a volume of water. One sees that, for a critical configuration to arise, two unlikely contingencies would have to occur simultaneously; namely, double batching of the prescribed limit of 400 grams of uranium-235 powder and the dumping of uranium-235 into water.

It is clear that safety planning much beyond this would become prohibitively costly with no significant increase in protection.

Basic Nuclear Safety Information

As we have indicated earlier, the presence of a hydrogeneous substance such as water or mineral tends to reduce the quantity of fissionable material required to sustain a nuclear chain reaction. The reason is something like this:

When a neutron is liberated by a fissioning uranium atom, it is given up with a substantial amount of kinetic energy or, to express it more colloquially, it has a high speed. The probability of its being captured by an adjacent uranium atom is substantially improved if it is slowed down. It can be slowed down best by colliding with a particle which has very nearly the identical mass. You can visualize this simply. A golf ball bouncing off a basketball loses, essentially, only a tiny fraction of its energy or is slowed down very little but a golf ball colliding with another golf ball can lose a sizable fraction of its energy. In fact, in a single interaction, it can lose all of its energy.

In a very similar way, the neutron is slowed down most effectively by its collision with the proton which is the nucleus of a hydrogen atom and has essentially the same mass as the neutron. Thus, the slowing down or the moderation of fission neutrons is effected best by hydrogeneous materials.

Dixon Callihan has published an unclassified digest of nuclear safety as it pertains to solutions of fissionable materials (Table I of this article).*

It should be made very clear that the values furnished in Table I apply to aqueous solutions of

**Callihan, Dixon. "Nuclear Safety in Processing Reactor Fuel Solutions,"* Nucleonics, *XIV, No. 47 (July, 1956), p. 39.*

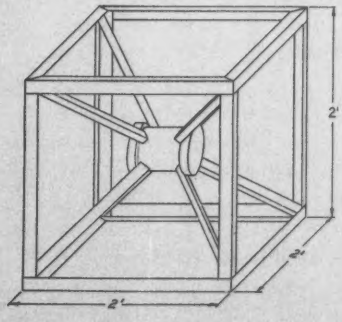

Figure 1—Typical birdcage cubical framework of rigid steel members. Container holding fissionable material is positioned in center of configuration to insure that material never can be closer than two feet from next storage package. Thus, if safe quantity is placed in each container, practically indefinite number can be stored in all directions. Birdcage is designed to withstand significant shock so that, in event of transportation accident or other similar disaster occurrence, integrity of physical shape of birdcage would be maintained.

light water in proximity to materials common in ordinary processing plants: water, concrete, stainless steel, etc. Sizable quantities of beryllium, graphite heavy water—i.e., those materials which are superior to light water for the production of a chain reaction—are understood not to be present.

Particular caution is indicated with respect to the volume, cylinder diameter and slab thickness dimensions. These are applicable only to homogeneous solutions of the fissionable element having a density of less than one gram per cubic centimeter in the fissionable element. For example, the minimum critical slab thickness for uranium-235 in the form of metal in a water bath is *considerably less than the 1.4 inches listed.*

Handling of Massive Metal

In the handling of massive metal the following will serve as an approximate guide:

A solid unreflected sphere of uranium-235 would be critical with a mass of approximately 50 kilograms. If it is totally reflected with light water, the critical mass is reduced by a factor of about two. Total or infinite water reflection is effected with about six inches of light water. Thus, in the form of massive metal, 20 kilograms of uranium-235 with sufficient physical separation from other assemblies can be stored with perfect nuclear safety, even allowing for inundation.

Practical use is made of such storage arrangements in so-called birdcage configurations. These are rigid iron frames in the center of which can be positioned a safe quantity of fissionable material in such a way that proximity closer than two feet, center to center, from other fissionable material is physically prevented. Such configurations are safe, essentially, irrespective of the number of birdcages that are stored side by side.

One question sometimes asked by persons processing normal isotopic uranium is what limitation, if any, is there on the quantity of normal uranium that can be processed in any single quantity. All experiments to date indicate that natural uranium cannot be made critical by use of light water moderation alone, so that for practical purposes no quantity of normal isotopic uranium constitutes a nuclear safety hazard.

Conclusions

In concluding these remarks, it should be pointed out that nuclear hazards simply are an addition to the total technological risk that industry already has taken and that, in relation to this total risk, criticality hazards certainly are not inordinately significant. Like any other industrial risk, a balance must be arrived at, based upon economic requirements and plant safety.

In the fabrication of special nuclear materials, sizable quantities may be processed wholly consistent with the requirements of industrial safety, as is manifested by more than a decade of incident-free operation.

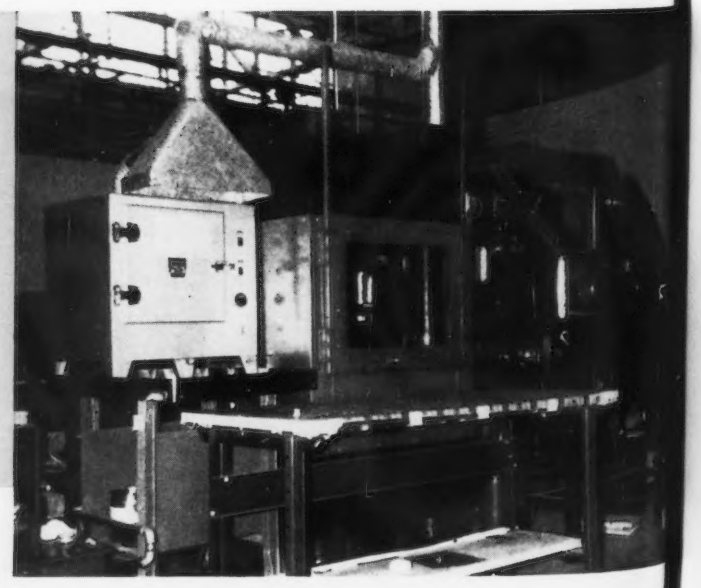

Figure 2—Typical equipment for production and handling of enriched powder. Notice size of equipment, made necessary by limitations imposed on quantity by nuclear safety considerations. Oven, at left, is protected by exhaust ventilation port above door opening and further protected against spillage by means of stainless steel tray in which oven is set. Press, at center, is completely enclosed, with door in front, and is ventilated through rear and side with further exhaust connections. Glove box, at right, also is exhausted.

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AMERICAN SOCIETY OF SAFETY ENGINEERS

Membership Information

THE American Society of Safety Engineers has established the following classifications of active membership.

MEMBER—To be eligible as a Member an applicant shall be at least thirty years of age and shall be engaged in safety engineering. In addition, he shall have either an engineering or science degree in an accredited college curriculum and the equivalent of eight full years' experience in safety engineering; or he shall have had the equivalent of ten full years' experience in safety engineering.

ASSOCIATE MEMBER—To be eligible as an Associate Member an applicant shall be at least twenty-five years of age and shall be engaged in safety engineering. In addition, he shall have either an engineering or science degree in an accredited college curriculum and the equivalent of three full years' experience in safety engineering; or he shall have the equivalent of five full years' experience in safety engineering; or he shall have either an engineering or science degree in an accredited college curriculum, ten years' experience in professional engineering work and one full year's experience in safety engineering; or he shall have twenty years' experience in engineering work, of which at least ten have been at the professional level, and one full year's experience in safety engineering.

JUNIOR MEMBER—To be eligible as a Junior Member an applicant shall be at least twenty years of age and shall be engaged in safety engineering work, which if pursued the required time will tend to qualify the applicant for the classification of Associate Member. In addition, he shall have either an engineering or science degree in an accredited college curriculum or he shall have had the equivalent of one full year's experience in safety engineering.

AFFILIATE MEMBER—The Society also provides a special classification, that of Affiliate Member, for those not professionally engaged in safety engineering. To be eligible as an Affiliate Member an applicant shall be at least twenty-five years of age and shall have contributed to the advancement of safety engineering through demonstrated achievement in some related field of interest in which he has been engaged for at least three years.

for additional information write to

The American Society of Safety Engineers
425 North Michigan Avenue
Chicago 11, Illinois
(or contact your local chapter)

Vision

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